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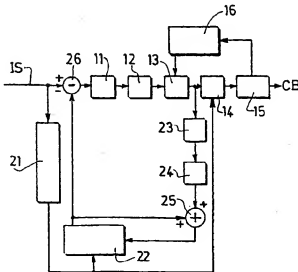
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(54) Title: VIDEO CODING METHOD AND CORRESPONDING TRANSMITTABLE VIDEO SIGNAL



(57) **Abstract:** The invention relates to a video coding method applied to a sequence of video frames and generating a coded bitstream constituted of video data that represent all the video object planes and are described in terms of separate channels. In said video data, each data item is described by means of a bistream syntax allowing any decoder to recognize and decode all the segments of the content of said bitstream. The temporal resolution of the sequence is described by means of some specific syntactic elements. According to the invention, which finds an application for instance within the video compression standards of the MPEG family, the syntax also comprises specific flags for describing, in the coded bitstream, the maximum frame rate of each described channel.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Video coding method and corresponding transmittable video signal

FIELD OF THE INVENTION

The present invention generally relates to the field of video compression and, for instance, more particularly to the video coding standards of the MPEG family (MPEG-1, MPEG-2, MPEG-4) and of the ITU-H.26X family (H.261, H.263 and extensions, H.26L).

- 5 More specifically, this invention concerns a video coding method applied to a sequence of video frames corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing to recognize and decode all the segments of the content
- 10 of said bitstream, the video data being described in terms of separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively define :
- a first number of evenly spaced sub-intervals per second, called "ticks" ;
 - second number of ticks between the successive VOPs in the display order ;
 - 15 - flag indicating whether or not all VOPs are coded with a fixed VOP temporal rate, the VOP rate being then derived either from said second number when it is fixed or from time stamps provided in each VOP header when it is variable.

- The invention also relates to a transmittable video signal consisting of a coded bitstream generated by means of the implementation of said coding method, and to a
- 20 decoding method and a decoding device for decoding said signal.

BACKGROUND OF THE INVENTION

- In the first video coding standards (up to MPEG-2 and H.263), the video is assumed to be rectangular and to be described in terms of three separate channels : one
- 25 luminance channel and two chrominance channels. With MPEG-4, additional channels have been introduced, for example the alpha channel (also referred to as the "arbitrary shape channel" in MPEG-4 terminology), the disparity channel, or the depth channel. The spatial and temporal resolutions of these channels are described at the sequence level (Video Object Layer, or VOL, in MPEG-4 terminology).

For the frame rate, only one description is given for all channels, as follows. The temporal resolution of the sequence is described by means of the following syntactic elements :

- "vop_time_increment_resolution" (coded on 16 bits),
 - 5 - "fixed_vop_rate" (coded on 1 bit), and
 - "fixed_vop_time_increment" (coded on 1 to 16 bits),
- as defined for instance in pages 36 and 112 of the MPEG-4 document w3056, "Information Technology – Coding of audio-visual objects – Part 2 : Visual", ISO/IEC/JTC1/SC29/WG11, Maui, USA, December 1999. These elements are now described in a more detailed manner.
- 10 The syntactic element "vop_time_increment_resolution" is a 16-bit unsigned integer that indicates the number of evenly spaced subintervals, called ticks, within one modulo time (modulo time represents the fixed interval of one second).

- The syntactic element "fixed_vop_time_increment" represent the number of ticks between two successive VOPs in the display order. The length of a tick, given by
- 15 "vop_time_increment_resolution", can take a value in the range [0, vop_time_increment_resolution]. The number of bits representing said value is calculated as the minimum number of unsigned integer bits required to represent the above range. This element "fixed_vop_time_increment" is only found in the bitstream if "fixed_vop_rate" is "1", and its value must be identical to the constant given by the distance between the display
- 20 time of any two successive VOPs in the display order. In this case, the fixed VOP rate is given as the ratio "vop_time_increment_resolution"/"fixed_vop_time_increment", a zero value being forbidden.

- The syntactic element "fixed_vop_rate" is a one-bit flag which indicates that all VOPs (pictures in MPEG-4 terminology) are coded with a fixed VOP temporal rate. Its
- 25 value is "1" if and only if all the distances between the display time of any two successive VOPS in the display order in the video object layer are constant. In this case, the VOP rate can be derived from the "fixed_vop_time_increment" syntactic element. If the value of the flag is "0", the display time between any two successive VOPs in the display order can be variable : it is then indicated by the time stamps provided in the VOP header.

- 30 In either case (fixed VOP rate or not), the display time of each encoded VOP is retrieved from the bitstream by a syntactic element "vop_time_increment" coded on 1 to 16 bits in the VOP header (see pp. 40 and 120 of the MPEG-4 document already cited). It can take a value in the range of [0 , vop_time_increment_resolution]. The number of bits representing said value is calculated as the minimum number of unsigned integer bits

required to represent the above range. The local time base in the units of seconds is recovered by dividing this value by "vop_time_increment_resolution".

- From the previous indications, it can be seen that, unfortunately, all channels have to share the same description. It is not possible to describe, for instance, a video sequence encoded at a frame rate of 30 Hz in luminance, 15 Hz in chrominance and 10 Hz in shape.

SUMMARY OF THE INVENTION

- It is therefore an object of the invention to propose a video coding method allowing to describe a video sequence with channels that have different frame rates.

To this end, the invention relates to a method such as defined in the introductory part of the description and which is moreover characterized in that said syntax also includes specific flags for describing, in the coded bitstream to be transmitted and/or stored, the maximum frame rate of each described channel.

- It is also an object of the invention to propose a transmittable video signal consisting of a coded bitstream generated by means of the implementation of a video coding method applied to a sequence of video frames corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing any decoder to recognize and decode all the segments of the content of said bitstream, the video data being described in terms of separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively define :

- a first number of evenly spaced sub-intervals per second, called "ticks" ;
 - a second number of ticks between the successive VOPs in the display order ;
 - a flag indicating whether or not all VOPs are coded with a fixed VOP temporal rate, the VOP rate being then derived either from said second number when it is fixed or from time stamps provided in each VOP header when it is variable ;
- said transmittable video signal including specific flags for describing, in the coded bitstream intended to be transmitted and/or stored, the maximum frame rate of each described channel.

The invention also relates to a video decoding method provided for receiving and decoding a A transmittable video signal consisting of a coded bitstream generated by means of the implementation of a video coding method applied to a sequence of video frames

- corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing any decoder to recognize and decode all the segments of the content of said
- 5 bitstream, the video data being described in terms of separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively define :
- a first number of evenly spaced sub-intervals per second, called "ticks" ;
 - a second number of ticks between the successive VOPs in the display order ;
 - 10 - a flag indicating whether or not all VOPs are coded with a fixed VOP temporal rate, the VOP rate being then derived either from said second number when it is fixed or from time stamps provided in each VOP header when it is variable ;
- said transmittable video signal including specific flags for describing, in the coded bitstream intended to be transmitted and/or stored, the maximum frame rate of each described channel.
- 15 The invention also relates to a corresponding decoding device.

BRIEF DESCRIPTION OF THE DRAWING

- The invention will now be described in a more detailed manner, with reference to the accompanying drawing in which Fig.1 shows an example of an MPEG coder with
- 20 motion compensated interframe prediction.

DETAILED DESCRIPTION OF THE INVENTION

- In the following description, it is assumed that the presence of channels is described by several syntactic elements at the sequence level (or VOL), these elements being
- 25 for example :

Video_object_layer_lum	1 bit
Video_object_layer_chrom	1 bit (0 for black and white)
Video_object_layer_shape	1 bit (0 for rectangular)
Video_object_layer_additional_channels	1 bit
30 Number_of_additional_channels	4 bits

These syntactic elements should be read as follows:

- if "Video_object_layer_lum" is 1, it means that the bitstream contains syntactic elements for a luminance channel ;

- if "Video_object_layer_chrom" is 1, the bitstream contains syntactic elements for the chrominance channels, else the sequence is assumed to be black and white ;
- if "Video_object_layer_shape" is 1, the bitstream contains syntactic elements intended to describe a non-rectangular shape for the picture, else the shape of the picture is assumed to be rectangular ;
- if "Video_object_layer_additional_channels_enable" is 1, the bitstream contains syntactic elements describing additional channels (in such a case, the variable "Number_additional_channels" holds the number of additional channels).

The proposed solution is then based on the introduction, at a high description level (equivalent to VOL MPEG-4 level), of the flag of Table 1, for describing the maximum frame rate of individual channels with reference to a global time base :

Table 1

Element	Type	Semantic
Vol_time_increment_resolution	16 bits	Global time increment resolution
Vol_time_increment_resolution_lum_ratio	4 bits	Ratio between global time increment and luminance channel time increment resolution
Vol_time_increment_resolution_chrom_ratio	3 bits	Ratio between global time increment and chrominance channel time increment resolution
Vol_time_increment_resolution_channels_ratio [i]	4 bits	Ratio between global time increment and i th additional channel time increment resolution
Vol_time_increment_resolution_lum	Integer	Luminance channel time increment resolution
Vol_time_increment_resolution_chrom	Integer	Chrominance channel time increment resolution
Vol_time_increment_resolution_channels [i]	Integer	i th additional channel time increment resolution

- These syntactic elements can be read from the bitstream, using the next pseudo C-code, which expresses the relationships between the channel presence and the availability of the syntactic elements. The function read_bits(n) returns the next unread "n" bits from the bitstream, and the default value of the syntactic element is 0 :

```

Vol_time_increment_resolution = read_bits (16) ;
If (Video_object_layer_lum)
{
    Vol_time_increment_resolution_lum_ratio = read_bits (4) ;
    If (Video_object_layer_chrom)

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Vol_time_increment_resolution_chrom_ratio = read_bits (3 ) ;
}
If (Video_object_layer_additional_channels)
{
For i = 0 ; i < number_of_additional_channels ; i++)
Vol_time_increment_resolution_channels_ratio[i]=readbits(4)
5      }
Vol_time_increment_resolution_lum =
Vol_time_increment_resolution / (Vol_time_increment_resolution_chrom_ratio + 1);
Vol_time_increment_resolution_chrom =
Vol_time_increment_resolution / (Vol_time_increment_resolution_chrom_ratio + 1);
10 Vol_time_increment_resolution_channels[i] =
Vol_time_increment_resolution/(Vol_time_increment_resolution_channels_ratio[i]+1)

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An example of implementation may be given. A sequence of the type CIF 4:2:2, encoded at a frame rate of 15 Hz in luminance and 10 Hz in chrominance, with binary shape at 30 Hz, would be described by the following parameters :

15

Channels presence description :

	Video_object_layer_lum	1
	Video_object_layer_chrom	1
	Video_object_layer_additional_channels	1
20	Number_of_additional_channels	1
	Video_object_layer_shape	1

Format per channels descriptions :

	Vol_time_increment_resolution	30 in decimal
25	Vol_time_increment_resolution_lum_ratio	0001
	Vol_time_increment_resolution_chrom_ratio	0010
	Vol_time_increment_resolution_shape_ratio	0000

The video coding method described above may be implemented in a coding device such as for instance the one illustrated in Fig.1 showing an example of an MPEG coder with motion compensated interframe prediction, said coder comprising coding and prediction stages. The coding stage itself comprises in series a mode decision circuit 11 (for

determining the selection of a coding mode I, P or B as defined in MPEG), a DCT circuit 12, a quantization circuit 13, a variable-length coding circuit 14 and a buffer 15 associated to a rate control circuit 16 for adapting the quantization according to the content of the buffer. The prediction stage comprises in series a motion estimation circuit 21 followed by a motion compensation circuit 22, and, in series, an inverse quantization circuit 23, an inverse DCT circuit 24 and an adder 25. A subtractor 26 allows to send towards the coding stage (11 to 16) the difference between the input signal IS of the coding device and the predicted signal available at the output of the prediction stage (i.e. at the output of the motion compensation circuit 22). This difference, or residual, is the bitstream that is coded, and the output signal CB of the buffer 15 is the coded bitstream that, according to the invention, will include the syntactic element indicating at a high description level, for each channel described in the coded bitstream, the presence, or not, of an encoded residual signal.

Another example of coding device may be based on the specifications of the MPEG-4 standard. In the MPEG-4 video framework, each scene, which may consist of one or several video objects (and possibly their enhancement layers), is structured as a composition of these objects, called Video Objects (VOs) and coded using separate elementary bitstreams. The input video information is therefore first split into VOs by means of a segmentation circuit, and these VOs are sent to a basic coding structure that involves shape coding, motion coding and texture coding. Each VO is, in view of these coding steps, divided into macroblocks, that consist for example in four luminance blocks and two chrominance blocks for the format 4:2:0 and are encoded one by one. According to the invention, the multiplexed bitstream including the coded signals that result from said coding steps will include the specific flags for describing, in the coded bitstream to be transmitted and/or stored, the maximum frame rate of each described channel.

Reciprocally, according to a corresponding decoding method, these specific flags, transmitted to the decoding side, are read by appropriate means in a video decoder receiving the coded bitstream that includes said flags and carrying out said decoding method. The decoder, which is able to recognize and decode all the segments of the content of the coded bitstream, reads said additional syntactic elements and knows the maximum frame rate of each described channel. Such a decoder may be of any MPEG-type, as the encoding device, and its essential elements are for instance, in series, an input buffer receiving the coded bitstream, a VLC decoder, an inverse quantizing circuit and an inverse DCT circuit. Both in the coding and decoding device, a controller may be provided for managing the steps of the coding or decoding operations.

The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously modifications and variations, apparent to a person skilled in the art and intended to be included within the scope of this invention, are possible in light of the above teachings.

It may for example be understood that the coding and decoding devices described herein can be implemented in hardware, software, or a combination of hardware and software, without excluding that a single item of hardware or software can carry out several functions or that an assembly of items of hardware and software or both carry out a single function. The described methods and devices may be implemented by any type of computer system or other adapted apparatus. A typical combination of hardware and software could be a general-purpose computer system with a computer program that, when loaded and executed, controls the computer system such that it carries out the methods described herein. Alternatively, a specific use computer, containing specialized hardware for carrying out one or more of the functional tasks of the invention could be utilized.

The present invention can also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods and functions described herein and —when loaded in a computer system— is able to carry out these methods and functions. Computer program, software program, program, program product, or software, in the present context mean any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following : (a) conversion to another language, code or notation ; and/or (b) reproduction in a different material form.

CLAIMS:

1. A video coding method applied to a sequence of video frames corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing to recognize and decode all the segments of the content of said bitstream, the video data being described in terms of separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively define :
- a first number of evenly spaced sub-intervals per second, called "ticks" ;
 - a second number of ticks between the successive VOPs in the display order ;
 - a flag indicating whether or not all VOPs are coded with a fixed VOP temporal rate, the VOP rate being then derived either from said second number when it is fixed or from time stamps provided in each VOP header when it is variable ;
- said syntax also including specific flags for describing, in the coded bitstream to be transmitted and/or stored, the maximum frame rate of each described channel.
2. A video coding method according to claim 1, in which said maximum frame rate of each channel is described by reference to a global time reference base.
3. A transmittable video signal consisting of a coded bitstream generated by means of the implementation of a video coding method applied to a sequence of video frames corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing any decoder to recognize and decode all the segments of the content of said bitstream, the video data being described in terms of separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively define :

- a first number of evenly spaced sub-intervals per second, called "ticks" ;
- a second number of ticks between the successive VOPs in the display order ;
- a flag indicating whether or not all VOPs are coded with a fixed VOP

temporal rate, the VOP rate being then derived either from said second number when it is

- 5 fixed or from time stamps provided in each VOP header when it is variable ;
said transmittable video signal including specific flags for describing, in the coded bitstream intended to be transmitted and/or stored, the maximum frame rate of each described channel.

4. A video decoding method provided for receiving and decoding a transmittable
10 video signal consisting of a coded bitstream generated by means of the implementation of a video coding method applied to a sequence of video frames corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing any
15 decoder to recognize and decode all the segments of the content of said bitstream, the video data being described in terms of separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively
define :

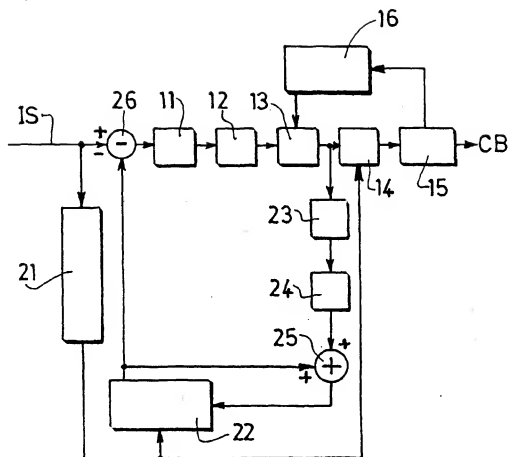
- 20 - a first number of evenly spaced sub-intervals per second, called "ticks" ;
- a second number of ticks between the successive VOPs in the display order ;
- a flag indicating whether or not all VOPs are coded with a fixed VOP
temporal rate, the VOP rate being then derived either from said second number when it is fixed or from time stamps provided in each VOP header when it is variable ;
25 said transmittable video signal including specific flags for describing, in the coded bitstream intended to be transmitted and/or stored, the maximum frame rate of each described channel.

5. A video decoding device for decoding a transmittable video signal consisting of a coded bitstream generated by means of the implementation of a video coding method
30 applied to a sequence of video frames corresponding to successive scenes and generating, for coding all the video objects of said scenes, a coded bitstream constituted of video data that represent all the successive, coded video object planes (VOPs) and in which each data item is described by means of a bitstream syntax allowing any decoder to recognize and decode all the segments of the content of said bitstream, the video data being described in terms of

separate channels comprising at least one channel, and the temporal resolution of said sequence being specifically described by means of syntactic elements which respectively define :

- a first number of evenly spaced sub-intervals per second, called "ticks" ;
 - 5 - a second number of ticks between the successive VOPs in the display order ;
 - a flag indicating whether or not all VOPs are coded with a fixed VOP temporal rate, the VOP rate being then derived either from said second number when it is fixed or from time stamps provided in each VOP header when it is variable ;
- said transmittable video signal including specific flags for describing, in the coded bitstream
- 10 intended to be transmitted and/or stored, the maximum frame rate of each described channel.

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FIG.1

INTERNATIONAL SEARCH REPORT

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 HO4N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the International search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	<p>INTERNATIONAL ORGANISATION FOR STANDARDISATION: "INFORMATION TECHNOLOGY - GENERIC CODING OF AUDIO-VISUAL OBJECTS: VISUAL ISO/IEC 14496-2 / AMD X" ISO/IEC JTC1/SC29/W611 N3095, XX, XX, December 1999 (1999-12), page COMPLETE XP000981674 paragraph '06.2! - paragraph '6.2.2! ----- -/-</p>	1-5

☒ Further documents are listed in the continuation of box C.☐ Patent family members are listed in annex.

* Special categories of cited documents:

A document defining the general state of the art which is not considered to be of particular relevance

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L document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

O document referring to an oral disclosure, use, exhibition or other means

P document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Z document member of the same patent family

Date of the actual completion of the international search

5 December 2002

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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/IB 02/04048

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	LIPPMAN, A.B. ET. AL.: "Single-Channel Backward-Compatible EDTV Systems" SMPTE JOURNAL, vol. 98, no. 1, 1 January 1998 (1998-01-01), pages 14-19, XP001121604 White Plains, NY abstract page 15, middle column, line 30 -page 16, left-hand column, line 15 -----	1-5
A	ARAKAWA H ET AL: "Software architecture for flexible and extensible image decoding" SIGNAL PROCESSING. IMAGE COMMUNICATION, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 10, no. 1-3, 1 July 1997 (1997-07-01), pages 235-248, XP004082709 ISSN: 0923-5965 page 246, right-hand column, paragraph 6.3 -page 247, left-hand column, paragraph 7 -----	1-5
A	EBRAHIMI T: "MPEG-4 video verification model: A video encoding/decoding algorithm based on content representation" SIGNAL PROCESSING. IMAGE COMMUNICATION, ELSEVIER SCIENCE PUBLISHERS, AMSTERDAM, NL, vol. 9, no. 4, 1 May 1997 (1997-05-01), pages 367-384, XP004075336 ISSN: 0923-5965 page 379, left-hand column, paragraph 3.4 -page 382, left-hand column, paragraph 3.5 -----	1-5

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